WATER RESOURCES INSTRUMENTATION

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ABSTRACT

Information is presented in tabular form on water resources instrumentation, manufacturers, distributors and prices to assist National Park Service personnel involved in water quantity and quality monitoring. Explanations of instrument types within six measurement categories are included. Suppliers of monitoring equipment, data bases and analytical software are provided in the Appendix.

INTRODUCTION

This technical report provides information on the types of field instrumentation available to measure and/or sample water resource attributes. The report is designed to be a quick-reference document that provides the user with information available from several sources in a condensed format. The instrumentation lists that follow do not represent a complete list of sampling equipment for all water resource parameters. They simply are examples of instruments that have maintained a successful record of performance based upon the author's experience and that of other Water Resources Division (WRD) staff. The focus of the presentation is on sampling in freshwater environments, however, many of the instruments are utilized in marine environments. Also, please note that the WRD does not endorse any brand name products.

This report is organized in a tabular format for six categories of water resource instrumentation. These categories include: (1) flow measurement; (2) stage (level) measurement; (3) physical and chemical water quality measurement; (4) biological water quality measurement; (5) water, soil and biota samplers; and (6) data storage and management. The tables are preceded by brief explanations of instrument types in each category. The tables provide lists of instrument types, manufacturers, distributors, model and part numbers, 1991/1992 prices, and comments (e.g. product/model names, descriptions, sizes, and component parts). Spaces are left at the end of each instrument type so that users can add instruments from other vendors to their lists. The names, mailing addresses and telephone numbers of the vendors listed are included in the Appendix for the user's reference.

BACKGROUND

Natural resource specialists, biologists, hydrologists, rangers and maintenance personnel working on lands managed by the National Park Service (NPS) frequently need to monitor water resource attributes in streams, lakes, springs, wells, wetlands, estuaries and oceans to evaluate baseline conditions or to detect changes that may be attributed to land uses or natural events. The two most frequently measured attributes are water quantity and quality, however, water-dependent habitats and fluvial geomorphic processes have been receiving increasing attention.

Water quantities commonly are measured to characterize flow regimes and ground water levels related to the water requirements of human and resource values. Also, water quantities are measured or estimated to evaluate rainfall-runoff relationships and determine the magnitude and frequency of floods that may inundate floodplain areas. Standardized methods are recommended for measuring water quantities in various natural and artificial settings (USDI 1977; Rantz et al. 1982). Often statistical parameters (minimum, maximum, median, mean) are used to describe normal baseflow levels, annual or seasonal runoff volumes for water uses, and/or peak flows. Peak flows are used in flood analyses and are important attributes in the analysis of geomorphic processes and conditions, and in the design of hydraulic structures. Magnitude and frequency of high flows commonly are evaluated using either annual or partial-duration series flood-frequency analyses (USDI 1982). Flow-duration analyses are used in assessments of flow availability for a range of flow conditions (floods, normal baseflows, droughts, etc.). Generally, they display monthly flow volumes (or daily flow rates) for selected values of flow exceedence. Water balance, or water budget, analyses occasionally are employed to measure local gains and losses between longitudinal stream reaches, or to construct a complete picture of inflows and outflows (including precipitation, streamflow, evapotranspiration losses, ground water gains and losses, water uses, etc.) for a stream, pond/lake, reservoir, wetland or entire watershed system.

Water qualities usually are measured to characterize the physical, chemical and biological condition of water resources, or to evaluate the impacts of water pollution from various sources on receiving water bodies. Pollutant sources may be defined as point sources (discharge from pipes or confined areas) or non-point sources (diffuse runoff from watersheds). Several common tests or measurements can be made in relation to the types of land use activities being evaluated (Kunkle et al. 1987; MacDonald et al. 1991). Generally, strategies are developed for the design and implementation of water quality monitoring plans. Good water quality monitoring plans focus on satisfying specific objectives, sample site selection, sample frequency, indicator parameters, instrumentation, logistics, sample analysis and data management (Ponce 1980a; Sanders et al. 1983; Kunkle et al. 1987). National Park Service guidance relating to monitoring design is contained in two recent documents

(NPS-77 1991; NPS-75, in preparation). Often water samples are collected in addition to measurement of water parameters in the field. Standardized methods for water quality measurement and sampling are available to assist those conducting water studies (USDI 1977; Kunkle and Wilson 1984). In addition, standardized procedures are recommended for quality assurance and control, sample handling (preservation, transportation, etc.), and laboratory analyses of water parameters within specific holding times (APHA 1989; Border et al. 1978; USEPA 1979a; USEPA 1979b). Water data results can be analyzed and interpreted to assess ambient conditions, impacts due to natural or human-caused sources, and/or water quality trends (UNESCO 1978; Ponce 1980b; Hem 1985). Often monitoring is conducted to determine whether particular water bodies are in compliance with state water quality standards. Federal water quality criteria provide the basis for most state standards (USEPA 1986).

Another method for assessing water quality is by sampling indicator organisms, or "biomonitoring". Although instrumentation for biomonitoring is not covered in-depth in this paper, references are provided to assist those in developing this component of a water quality monitoring program (USEPA 1985; USEPA 1989a; USEPA 1989b).

INSTRUMENTATION

Flow Measurement

Flow (streamflow, discharge, etc.) is the basic property of water transport in streams, rivers, springs and pipes. Flow or discharge is defined as a unit volume of water moving past a point in a unit period of time. In a stream, flow is calculated by multiplying the width of the stream times the average depth times the average velocity of the moving water. The units of flow are most often in cubic feet per second (cfs), cubic meters per second (cms), gallons per minute (gpm) or acre-feet per day, month, or year.

Rotating-cup current meters, such as the Price and Pygmy Type meters, mounted on wading rods are the most common instruments used to determine flow. They measure flow velocity in cross-sectional cells that are delineated by a tape or tagline across a stream. Summation of the products of length, depth and velocity from the individual cells results in the total flow. Electromagnetic flow meters measure the voltage generated by current movement past a sensor unit containing two electrodes. That voltage is directly proportional to velocity. Fluorometers measure flow movement (time-of-travel), flow discharge, and flow/pollutant dispersion and diffusion using fluorescent dye tracers. Parshall flumes and weirs measure flow height changes through contracted openings which are calibrated to represent flow discharge. Ultrasonic velocity/flow recorders are recent modifications of ultrasonic level technology where sound waves are transported through water and bounced of reflector plates. By positioning the plates in a certain way, time of travel or velocity and discharge of the flowing water can be calculated. Examples of the above mentioned instruments are presented in Table 1. Many of these instruments can be adapted to monitor flow in water or sewage delivery systems.

Table 1. Flow Measurement

Type	Manufacturer	Distributor	Model/Part No.	Price	Comments
Price Type "AA" Current Meters	U.S. Geological Survey	Hydrologic Instrum. Facil.	1101001	864.00	
	Teledyne Gurley	Teledyne Gurley	622AA	1,097.00	add $1,295 for digital flow indicator (Model 1100)
	" "	" "	622D	1,333.00	w/ earphone, case
	" "	Forestry Suppliers	94982	2,940.00	w/ wading rod, digital flow indicator
	Scientific Instruments	Scientific Instruments	1210	770.00	
Pygmy Type Current Meters	U.S. Geological Survey	Hydrologic Instrum. Facil.	1103001	516.00	
	Teledyne Gurley	Teledyne Gurley	625AA	682.00	add $1,295 for digital flow indicator (Model 1100)
	" "	" "	625D	782.00	w/ earphone, case
	" "	Forestry Suppliers	94992	1,320.00	w/ wading rod
	Scientific Instruments	Scientific Instruments	1205	618.00	
Electomagnetic Current Meters	Marsh McBirney	Marsh McBirney	201	2,150.00	GSA contract
	" "	" "	2000	2,995.00	
Fluorometers	Turner Designs	Turner Designs	Model 10-AU-005	7,240.00	add $395.00 for rhodamine optical kit (#10-041)
Top-Setting Wading Rods	U.S. Geological Survey	Hydrologic Instrum. Facil.	2101001	330.00	
	Teledyne Gurley	Teledyne Gurley	299-309	525.00	
	Scientific Instruments	Scientific Instruments	1246	380.00	
	Marsh McBirney	Marsh McBirney	75013	525.00	GSA contract
Taglines	U.S. Geological Survey	Hydrologic Instrum. Facil.	1301001	182.40	reel w/ 300 feet, 1/32 inch stainless steel cable
	Scientific Instruments	Scientific Instruments	1100	555.00	reel w/ 300 feet, 0.04 inch stainless steel cable
	" "	" "	1105	555.00	reel w/ 100 meter, 0.1 cm stainless steel cable
Weirs					
Flumes	U.S. Geological Survey	Hydrologic Instrum. Facil.	1211001	360.00	Parshall w/ 3-inch throat (0.002 - 0.70 cfs)
	T.N./Manning Products	T.N. Technologies	PF-3	390.00	Parshall w/ max. free flow discharge = 1.2 cfs
	" " "	" "	PF-18	1,590.00	Parshall w/ max. free flow discharge = 15.9 cfs
	Baski, Incorporated	Baski, Incorporated	CTF-1	228.00	Cutthroat w/ interchang. wing walls, throat plates
	" "	" "	CTF-2	234.00	" " " " " "
	" "	" "	CTF-4	244.00	" " " " " "
	" "	" "	CTF-8	263.00	" " " " " "
Ultrasonic Velocity Recorders	Stork Acoustical	Stork Acoustical	Surflow Mark 1	12,000.00	
	ORE International	ORE International	Accusonic 7300	8,500.00	w/ 2 transducers, add $7,000 for responder

Stage (Level) Measurement

Stage, or water level, is a similar category to flow in that it is a characterization of how much water is present in streams, rivers, lakes, reservoirs, wells, or on the level surface with respect to snow. Commonly, water stages in streams and rivers are converted to flows by ratings of stage versus discharge based on periodic field measurements. Ratings are curvelinear functions that are plotted on graph paper. They represent relationships between stage and discharge for particular stream cross-sections at specific points in time. Ratings change periodically due to changes in channel bed elevations and shapes. Water levels in wells are measured to assess ground water gradients, movement, drawdown, recharge, and aquifer capacities. Occasionally, tide levels are measured using stage recording devices.

For surface waters, stage in feet or meters is measured by using either staff gage observations, float-type water level recorders, ultrasonic water level recorders, bubbler manometers or pressure transducers. A staff gage is simply a calibrated ruler that is inverted and placed in a stream or lake. A float-type recorder consists of a chart recorder connected to a float that is housed in a stilling well. An ultrasonic recorder is an instrument placed above a water body that bounces a sound signal off the water surface which is in turn collected and recorded back at the unit. A bubbler manometer forces a gas bubble from an orifice beneath the water's surface. The pressure required to force the gas bubble from the orifice is related to the weight or height of water over the orifice. A pressure transducer measures the pressure on the sensor due to the weight of water over it. All these instruments can be equipped with chart mechanisms or dataloggers to record and store the stage data.

Ground water levels usually are measured by lowering electronic cables or calibrated steel tapes into wells. The electronic cables complete an electrical circuit when they contact the water. Ground water levels also can be measured using float-type recorders, pressure transducers and potentiometers. The snow tube is a standard instrument used to collect snow depth and water equivalent data. Examples of these instruments are included in Table 2.

Table 2. Stage (Level) Measurement

Type	Manufacturer	Distributor	Model/Part No.	Price	Comments
Float Type Water Level Recorders	Leupold & Stevens	Leupold & Stevens	7001	2,395.00	w/ timer, float tape and 5 in. float (metric #7002)
	" "	" "	Type A-71	2,888.00	w/ Chelsea clock, pulley, line, 10 in. float
	" "	" "	Type F	1,243.00	w/ QMT clock, pulley, line, 5 in. float (eng./met.)
	" "	Forestry Suppliers	Type F/90800	1,145.00	english (metric #90801)
	Belfort	" "	5-FW/90880	1,795.00	
	Solinst	" "	301/90900	2,985.00	add $150.00 for well casing connector (#90901)
Ultrasonic Water Level Recorders	T.N./Manning Products	T.N. Technologies	UL-1100	3,150.00	
	" " "	" "	UF-1100	3,715.00	level to flow conversion
	" " "	" "	UD-1100	4,100.00	level to flow conversion w/ datalogger; add $2,160 for IBM interface kit
	Isco Environ. Division	Isco Environ. Division	68-3210-001	2,493.00	w/ datalogger; add $995.00 for Flowlink. GSA
Bubbler Manometers	U.S. Geological Survey	Hydrologic Instrum. Facil.	1213100	3,000.00	PS2 w/ SDI-12 interface
	Scientific Instruments	Scientific Instruments	7735	3,889.00	STACOM
	Isco Environ. Division	Isco Environ. Division	68-3230-001	2,863.00	w/ datalogger; add $995.00 for Flowlink. GSA
Pressure Transducers	Leupold & Stevens	Leupold & Stevens	SDT-II 10 /45553	610.00	10 feet range w/ 30 feet cable
	Druck	Druck	PDCR 830	485.00	5 psi sensor
	Isco Environ. Division	Isco Environ. Division	68-3220-001	2,678.00	w/ datalogger; add $995.00 for Flowlink. GSA
Staff Gages	U.S. Geological Survey	Hydrologic Instrum. Facil.	1201001	10.80	0 - 3.33 feet
	Leupold & Stevens	Leupold & Stevens	Style A/15415	37.00	" " "
	" "	" "	Style C/15405	27.00	" " "
	Scientific Instrumeats	Scientific Instruments	Style A/6100	63.00	" " "
	" "	" "	Style C/6300	47.00	" " "
	Forestry Suppliers	Forestry Suppliers	Style A/39725	37.50	" " "
	" "	" "	Style C/39732	27.25	" " "
Groundwater Level Meters (Electronic)	Leupold & Stevens	Leupold & Stevens	Type L/43704	475.00	100 meters/328 feet
	Solinst	Forestry Suppliers	90792	640.00	300 feet
	Fisher	" "	WLS/90780	244.00	300 feet
	Soiltest, Incorporated	Soiltest, Incorporated	446-020	935.00	300 feet
Steel Tapes (Black Neubin)	U.S. Geological Survey	Hydrologic Instrum. Facil.	1309003	648.00	300 feet
Snow Tubes	Carpenter Machine Works	Carpenter Machine Works	standard	1,474.00	w/ cutter, 3 30-inch aluminum sections, scale, drive wrench, spaners, thread protector, case

Physical and Chemical Water Quality Measurement

The category of physical and chemical water quality measurement represents instrumentation used to measure physical and chemical parameters in the field, and apparatus used to prepare water samples for chemical laboratory analyses. In general, the basic physical parameters that are measured during field investigations of water quality include flow, air and water temperature, specific electrical conductance (EC), salinity, hydrogen-ion activity (pH), dissolved oxygen (DO), redox potential (Eh or ORP), depth and turbidity. Single parameter and multiparameter sensors are readily available from numerous vendors to measure these physical constituents in water. A selection from this group is presented in Table 3. The user is encouraged to revise or update this list to suit their purposes. Chemical standards and buffers are included for calibration of pH and conductivity meters. In addition to the sensors listed, specific chemical electrodes are available from some vendors that measure nitrate, ammonia, chloride and several other chemical parameters.

The portable laboratory is an example of a water quality kit that contains a spectrophotometer, reagents, digital titrator, pH meter and conductivity meter. Spectrophotometers measure light absorbencies and resultant chemical concentrations by passing specific wavelengths of light through samples to a detector. Fluorometers measure the natural fluorescence of chlorophyll and aromatic hydrocarbons, and light scattering properties related to water clarity.

Water samples commonly are collected in the field and transported to certified laboratories for analysis of specific suites of inorganic and organic chemical parameters. These parameters may include: cations, anions, nutrients, sediments, heavy metals, radionuclides, pesticides, volatile and semi-volatile hydrocarbons, etc. Peristaltic pumps, filters and filter holders are included because often water samples must be filtered in the field for dissolved constituent analysis in the laboratory, especially for nutrients and heavy metals.

Table 3. Physical and Chemical Water Quality Measurement					
Type	Manufacturer	Distributor	Model/Part No.	Price	Comments
Portable Laboratories	HACH Company	HACH Company	DREL/2000 45250-05	3,195.00	w/ spectrophotometer, digital titrator, reagents, pH and conductivity meters
Multiparameter Meters	HYDROLAB Corporation	HYDROLAB Corporation	H20	3,690.00	transmitter w/ EC, salinity, temperature, pH, DO sensors, stirrer, 5 meter cable, interface and case
	" "	" "	Scout 2	4,985.00	w/ same as above, plus display unit
	" "	" "	Surveyer 3	6,640.00	w/ same as above, plus datalogger and internal battery
	" "	" "	Datasonde 3	7,045.00	w/ same as above, plus redox (ORP), depth sensors, and 25 meter cable
	Yellow Springs/Grant	Yellow Springs Instrum.	3800	5,995.00	transmitter w/ EC, salinity, temperature, pH, DO sensors; add $2,175.00 for ORP, depth, turbidity and ammonium sensors
	" " "	Forestry Suppliers	3800/76900	5,995.00	same as above
Conductivity and Salinity Meters	Yellow Springs Instrum.	Yellow Springs Instrum.	33 S-C-T	615.00	w/out probe
	" " "	Forestry Suppliers	33 S-C-T/76178	625.00	add $165.00 for probe (# 76179)
	" " "	VWR Scientific	" /66121-254	615.00	add $156.00 for probe (#66121-276)
	Orion Research	Orion Research	122	655.00	w/ probe
	" "	VWR Scientific	122/23197-939	655.00	w/ probe
	Beckman/Rosemount	" "	RC16D/23195-125	905.00	add $100.00 for probe (#23196-659)
pH Meters	HACH Company	HACH Company	Hach One/43800	495.00	w/ probe
	Orion Research	Orion Research	0250A0	625.00	w/ ATC probe
	" "	" "	0250A3	715.00	w/ ATC probe, standards and case
	" "	VWR Scientific	250A/34104-120	625.00	w/ ATC probe
Dissolved Oxygen Meters	Yellow Springs Instrum.	Yellow Springs Instrum.	50 B	965.00	w/out probe
	" " "	VWR Scientific	50 B/52456-121	965.00	add $317.00 for probe (#52457-010) and cable assembly (#52457-155)
	" " "	Forestry Suppliers	50 B/76190	965.00	add $345.00 for probe (#76168) and cable assembly (#76169)
	Orion Research	Orion Research	820	995.00	w/ probe
	" "	VWR Scientific	820/52458-050	995.00	w/ probe
Turbidimeters	HACH Company	HACH Company	2100 P	895.00	
Fluorometers	Turner Designs	Turner Designs	Model 10-AU-005	7,240.00	add $399.00 for chlorophyll optical kit (#10-040)
Thermographs	Ryan	Forestry Suppliers	"J"/89357	650.00	w/ range 0 - 30 degrees Centigrade
	"	" "	TempMento/89381	712.00	

Table 3. Physical and Chemical Water Quality Measurement

Type	Manufacturer	Distributor	Model/Part No.	Price	Comments
Standards and Buffers	Banco	VWR Scientific	AL51340-4	15.90	KCl conductance standard, 0.01 M, 32 oz.
	VWR Scientific	" "	34180-617	13.55	pH 4.00 (red) buffer, 0.5 liters
	" "	" "	34180-640	13.55	pH 7.00 (yellow) buffer, 0.5 liters
	" "	" "	34180-672	13.55	pH 10.00 (blue) buffer, 0.5 liters
Peristaltic Pumps	Geotech Environ. Equip.	Geotech Environ. Equip.	Geopump 1/0740	567.00	12 volt DC/115 volt AC
Filter Holders	Geotech Environ. Equip.	Geotech Environ. Equip.	0805	256.50	142 mm diameter, acrylic, GSA contract
	" " "	" " "	0815	540.00	90 mm diameter, stainless steel, GSA contract
	" " "	" " "	0820	382.50	47 mm diameter, stainless steel, GSA contract
	" " "	" " "	0920	18.00	47 mm diameter, poly-carbonate, GSA contract
Filters (cellulose acetate)	Geotech Environ. Equip.	Geotech Environ. Equip.	GA045142	122.00/50	142 mm diameter, 0.45 um pore size
	" " "	" " "	GA045090	169.00/100	90 mm diameter, 0.45 um pore size
	" " "	" " "	GA045047	52.00/100	47 mm diameter, 0.45 um pore size

Biological Water Quality Measurement

The category of biological water quality measurement represents the instrumentation used for analysis of five common groups of indicator bacteria in water samples. Instrumentation used in analyses for other biological microorganisms in water, such as protozoa (giardia, cryptosporidium, etc.) and viruses, that cause human health problems are not included due to the specific nature of their use. Most of those organisms are collected by high volume filters and are identified by visual plate count.

The five groups of indicator bacteria are: total coliform, fecal coliform, *Escherichia coli*, fecal streptococci, and enterococci. Most of the bacteria are analyzed by membrane filtration or most probable number methods. In general, none of the indicator bacteria are intestinal pathogens, but their lifespans and living requirements are similar to bacteria that cause disease in animals and humans. Analyses of total coliform bacteria are required by state and federal law to evaluate drinking water quality. Fecal coliform and fecal streptococci bacteria commonly are analyzed to measure water contamination from human and animal wastes, respectively. In marine waters, total coliform and fecal coliform bacteria are analyzed in shellfish harvest areas. Recently, the U.S. Environmental Protection Agency (USEPA) recommended that states adopt *E. coli* and enterococci standards for freshwater bathing (USEPA 1986). *E. coli* is a serological subgroup species of fecal coliform bacteria. Enterococci is a group of bacterial species within the Lancefield's Group D streptococci, a serological subgroup of fecal streptococci. Instrumentation used to collect water samples, filter the samples, and culture the bacterial colonies are included in Table 4.

Table 4. Biological Water Quality Measurement

Type	Manufacturer	Distributor	Model/Part No.	Price	Comments
Filtering Apparatus	Millipore Corporation	Millipore Corporation	XKFC 001 00	1,374.00	fecal coliform field kit
	" "	" "	MHWG 055 00	72.00/50	disposable, w/ filters; add $109.00 for flask/stopper/tubing
	Nalge	VWR Scientific	28198-630	47.40/12	disposable, w/ 47 mm diameter, 0.45 um pore size filters
	"	HACH Company	Type A/22530-00	46.80/12	disposable, w/ filters; add $13.50 for holder (#22531-00)
Membrane Filters (mixed esters of cellulose)	Millipore Corporation	Millipore Corporation	HAWG 047 S3	76.20/200	47 mm diameter, 0.45 um pore size
	" "	" "	HCWG 047 S3	73.90/200	47 mm diameter, 0.7 um pore size
	Gelman Scientific, Inc.	VWR Scientific	GN-6/28148-926	68.00/200	47 mm diameter, 0.45 um pore size
	" " "	HACH Company	GN-Metricel	92.00/200	47 mm diameter, 0.45 um pore size
Media	Millipore Corporation	Millipore Corporation	M000 000 2E	17.10/24	Total Coliform MF-Endo, 2 ml glass ampules
	" "	" "	M000 0GP 2E	15.50/20	Total Coliform MF-Endo, 2 ml plastic ampules
	" "	" "	MB00 000 0E	33.00/110 g	Total Coliform MF-Endo, dehydrated
	" "	" "	M000 00P 2F	40.40/50	Fecal Coliform M-FC, 2 ml plastic ampules
	" "	" "	MB00 000 0F	36.30/110 g	Fecal Coliform M-FC, dehydrated
	" "	" "	MB00 000 0S	49.90/110 g	Fecal Streptococci KF Agar, dehydrated
	HACH Company	HACH Company	23735-20	14.00/20	Total Coliform m-Endo, 2 ml glass ampules
	" "	" "	23732-20	16.50/20	Fecal Coliform M-FC, 2 ml glass ampules
	" "	" "	22811-26	22.15/100 g	E. Coli m-TEC Agar, dehydrated
	" "	" "	22812-26	24.95/100 g	Enterococci m-E Agar, dehydrated
	" "	" "	14853-01	58.60/454 g	Fecal Streptococci KF Agar, dehydrated
Incubators	Millipore Corporation	Millipore Corporation	XX63 004 00	1,936.00	12 volt DC/115 volt AC, 44.5 & 35 degrees C
	" "	" "	XX63 200 00	1,800.00	12 volt DC/115 volt AC; 44.5, 41.5, 41, 37, & 35 deg. C
Vacuum Pumps	Millipore Corporation	Millipore Corporation	XX55 000 00	575.00	115 volt, 60 Hz motor
	Nalge	HACH Company	14283-00	35.30	hand-operated
	Gast	" "	14697-00	267.00	115 volt, 60 Hz motor, 1.3 cfm
Assessories (flasks, bottles, syringes, pipets, petri dishes, etc.)	Millipore Corporation	Millipore Corporation	PD10 047 S0	23.00/100	sterilized petri dishes and pads
	Nasco	Hach Company	22331-99	9.75/100	sterilized Whirl-Pak bags, 0.2 liters
	"	" "	20753-33	13.75/100	sterilized Whirl-Pak bags w/ sodium thiosulfate, 0.2 liters
	Nalge	VWR Scientific	16125-107	23.80/6	wide-mouth high-density polyethylene bottles, 1 liter
	"	" "	16338-017	56.65	high-density polyethylene carboy w/ spigot, 9 liters
	"	" "	16651-595	12.05/4	wide-mouth polyethylene wash bottles, 0.5 liters
	VWR Scientific	" "	53283-366	58.24/200	sterile, plugged plastic pipets, individually wrapped, 10 ml
	Plastipak	" "	BD9663	37.25/30	plastic syringes, 60 cc x 5 cc

Water, Sediment and Biota Samplers

Various types of equipment employed for collecting water, sediment and biota samples are included in Table 5. The DH-48 and DH-75 are hand-held suspended sediment samplers that collect depth-integrated samples of water or water and sediment mixtures in individual bottles. The Helly-Smith is a hand-held sampler that collects bedload sediment in a mesh bag. Automatic samplers collect one large water sample or several samples over chosen time periods while left unattended. Lake samplers are essentially cylindrical containers with two rubber stopper ends that are spring loaded. When the bottles are lowered to chosen depths, messengers actuate closing mechanisms to collect the water samples. Bottom dredges collect samples of lake bottom sediments in the same fashion. Well samplers are small-diameter steel bottles that function like the lake samplers or are bailers that fill through specially designed orifices. Soil water samplers collect water samples by using vacuum pressure to extract water from the surrounding soil. Lastly, the Surber sampler is the most common means to collect macroinvertebrates in streams and rivers. However, many other types of samplers can be used to collect benthic and planktonic organisms, such as drift nets, plankton nets, Hess samplers, McNeil samplers, freeze-core samplers, and artificial substrates.

Table 5. Water, Sediment and Biota Samplers

Type	Manufacturer	Distributor	Model/Part No.	Price	Comments
Suspended Sediment Samplers	U.S. Army Corps of Eng.	Federal Interagency Sedimentation Project (ISP)	DH-48	259.00	add $25.00 for 3 ft. wading rod
	" " " " "		DH-75	199.00	add $25.00 for 3 ft. wading rod
	Scientific Instruments	Scientific Instruments	DH-48/5200	189.00	add $47.00 for 3 ft. wading rod (# 5215)
Bedload Samplers	Helly-Smith	GBC, Incorporated	3 X 3 inch	195.00	add $32.00 for bag
Automatic Samplers	T.N./Manning Products	T.N. Technologies	PSC-4900	2,510.00	w/ controller, 24 bottle carriage, battery & charger
	" " "	" "	PSC-6900	3,415.00	w/ controller, 24 bottle carriage, refrigerator
	Isco Environ. Division	Isco Environ. Division	68-2900-001	1,895.00	w/ 24 0.5-liter bottles; add $275.00 for battery and suction line
	" " "	" " "	68-3700-001	2,495.00	w/ 24 1-liter bottles; add $280.00 for battery and suction line
Lake Samplers	Wilco Instruments	Forestry Suppliers	77242	297.00	2.2 liter Alpha bottle
	" "	" "	77199	277.00	2.2 liter Beta Plus bottle
	" "	" "	77270	243.00	1.2 liter Kemmerer bottle, stainless
	" "	" "	77276	174.00	1 liter water bottle
	" "	" "	77273	334.00	w/ 1 liter bottle, Secchi disk, net, thermometer
	" "	" "	77278	86.00	Secchi disk
	Wilco - Ekman	" "	77251	271.00	bottom dredge
	Soiltest, Incorporated	Soiltest, Incorporated	432-005	411.00	1.2 liter Kemmerer bottle, stainless
	" "	" "	430-350	460.00	bottom dredge
Well Samplers	Wilco Instruments	Forestry Suppliers	77241	325.00	0.6 liter 2" Kemmerer bottle, stainless
	" "	" "	77197	318.00	1.2 liter 4" Kemmerer bottle, stainless
	Norton Norwell	" "	78274	199.00	1 liter teflon bailer w/ standard top & bottom
	Soiltest, Incorporated	Soiltest, Incorporated	433-100	1,305.00	portable pump kit (including Geopump 1)
	" "	" "	431-033	150.00	1 liter teflon bailer w/ cap
	" "	" "	432-010	512.00	0.6 liter 2" Kemmerer bottle, stainless
	AccuWell	Isco Environ. Division	60-3004-060	695.00	portable pump PTP-100; add $275 for battery and suction line
	"	" " "	68-4600-002	205.00	1 liter bailer BLR-130
Soil Water Samplers	Soiltest, Incorporated	Soiltest, Incorporated	426-200	50.00	ceramic cup
	" "	" "	426-900	118.00	vacuum service unit used w/ # 426-200
	" "	" "	426-000	104.00	lysimeter
Stream Biota Samplers	Wilco Instruments	Forestry Suppliers	77246	155.00	Surber sampler

Data Storage and Management

Data storage and management is a category worthy of much more consideration than is presented in this report. However, examples of common hardware and software that are available are included in Table 6. Datalogger technology has considerably advanced the field of data storage and retrieval. The new dataloggers are small, compact, easy to use, and essentially are powerful microcomputers that can be attached to most recording equipment. The STORET and WATSTORE databases are national mainframe databases that can be accessed by personal computers. STORET is a USEPA database that contains water quality data. WATSTORE is a U.S. Geological Survey (USGS) database that contains daily flow, peak flow and water quality data. The EarthInfo databases are compact disk (CD-ROM) versions of the USGS WATSTORE and National Climatic Data Center databases. The U.S. Army Corps of Engineers, Hydrologic Engineering Center (USCOE/HEC) hydrology models are used to calculate surface runoff, flood routing, water surface elevations, scour and deposition, and flood-flow frequency. Most of the HEC models (HEC-1, HEC-2, HEC-6, HECWRC, etc.) are available free of charge to other federal agencies from the USCOE. The Soil Conservation Service models TR-55 and TR-20 employ curve number techniques to calculate peak flow runoff (McCuen 1982).

Table 6. Water Resources Instrumentation: Data Storage and Management

Type	Manufacturer	Distributor	Model/Part No.	Price	Comments
Dataloggers	Leupold & Stevens	Leupold & Stevens	Type A/F	708.00	GSA contract
	" "	" "	420 Level	752.00	GSA contract
	Campbell Scientific, Inc.	Campbell Scientific, Inc.	CR-10	2,170.00	w/ datalogger, display, storage module, power supply, PC interface, software. GSA contract
	" " "	" " "	BDR-320	965.00	w/ datalogger, enclosure, power supply, software
	Omnidata	Omnidata	EL-925	1,557.00	Easylogger w/ 8K RAM, 64K ROM. GSA contract
	"	"	PC-602	1,183.00	Polycorder w/ 128K memory. GSA contract
Databases	U.S. Environ. Pro. Agen.	U.S. Environ. Pro. Agen.	STORET		
	U.S. Geological Survey	U.S. Geological Survey	WATSTORE		
	EarthInfo, Incorporated	EarthInfo, Incorporated	Hydrodata	595.00/disk	
	" "	" "	Climatedata	595.00/disk	
Software/ Models	U.S. Army Corps of Eng.	Hydrologic Engin. Center	HEC-1		flood hydrograph, peak flow runoff, flood routing
	" " " " "	" " "	HEC-2		channel cross-sections, water surface profiles
	" " " " "	" " "	HEC-6		channel scour and deposition
	" " " " "	" " "	HECWRC		flood flow frequency analysis (Log Pearson III)
	Soil Conservation Service	Soil Conservation Service	TR-55		peak flow runoff
	" " "	" " "	TR-20		peak flow runoff
	Haestad Methods	Haestad Methods	HEC-1	495.00	flood hydrograph
	" "	" "	HEC-2	495.00	water surface profiles
	" "	" "	HEC-PLOT	295.00	graphics plotting
	" "	" "	Friend	495.00	data entry
	" "	" "	HEC PACK	795.00	includes Friend, HEC-1, HEC-2, HEC-Plot
	" "	" "	POND-2	990.00	detention pond design
	" "	" "	Quick TR-55	495.00	peak flow runoff
	" "	" "	POND PACK	995.00	Includes Quick TR-55 and Pond 2
	" "	" "	HECWRC	495.00	flood flow frequency

SUMMARY

This report is designed to be a working reference. Tabular information is presented on water resource instrumentation, manufacturers, distributors and prices. Since the information presented here can be out-dated quickly, users are encouraged to update the tables on an annual basis by calling the vendors listed in the Appendix. Also, users are encouraged to send additional information to the WRD to assist in the development of a centralized database for periodic updates of this report. The original tables are available in WordPerfect 5.1 format by contacting the WRD.

If you have any questions regarding the content of the tables, additions to the instrument lists, or other specific needs concerning water resource instrumentation and monitoring, please contact the author at the address listed in the front of this report. The staff of the WRD are willing and able to assist in project design, instrument selection, training, and data management and interpretation.

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U.S. Environmental Protection Agency. 1985. Methods for measuring the acute toxicity of effluents to freshwater and marine organisms (3rd ed.). EPA-600/4-85-013. U.S. EPA, EMSL, Cincinnati, OH. 216 pp.

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APPENDIX

MAILING ADDRESSES AND TELEPHONE NUMBERS OF VENDORS

Campbell Scientific, Incorporated
815 West 1800 North
P.O. Box 551
Logan, UT 84321
(801) 753-2342

Carpenter Machine Works
1024 North 36th Street
Seattle, WA 98103
(206) 632-2755

Druck Incorporated
4 Dunham Drive
New Fairfield, CT 06812
(203) 746-0400

EarthInfo, Incorporated
5541 Central Avenue
Boulder, CO 80301
(303) 938-1788
(800) 222-0920

Federal Interagency Sedimentation Project
St. Anthony Falls Hydraulic Laboratory
3rd Avenue S.E. and Hennepin Island
Minneapolis, MN 55414
(612) 370-2361

Forestry Suppliers, Incorporated
P.O. Box 8397
205 West Rankin Street
Jackson, MS 39284
(601) 354-3565
(800) 647-5368

GBC, Incorporated
190 South Union Boulevard
Lakewood, CO 80228
(303) 988-6450

Geotech Environmental Equipment, Inc.
1441 West 46th Avenue, #17
Denver, CO 80211
(303) 433-7101

HACH Company
P.O. Box 608
Loveland, CO 80539
(303) 669-3050
(800) 227-4224

Haestad Methods
37 Brookside Road
Waterbury, CT 06708
(203) 755-1666
(800) 727-6555

HYDROLAB Corporation
P.O. Box 50116
Austin, TX 78763
(512) 255-8841

Isco Environmental Division
531 Westgate Boulevard
Lincoln, NE 68528
(402) 474-2233
(800) 228-4373

Marsh McBirney, Incorporated
4539 Metropolitan Court
Frederick, MD 21701
(301) 874-5599
(800) 368-2723

Millipore Corporation (East)
Bedford, MA 01730
(617) 875-2050
(800) 225-1380

Millipore Corporation (West)
448 Grandview Drive
South San Francisco, CA 94080
(415) 952-9200
(800) 632-2708

Omnidata International, Incorporated
P.O. Box 3489
Logan, UT 84321
(801) 753-7760

ORE International
P.O. Box 709
Falmouth, MA 02541
(508) 548-5800

Orion Research, Incorporated
529 Main Street
Boston, MA 02129
(617) 242-3900
(800) 225-1480

Scientific Instruments, Incorporated
518 West Cherry Street
Milwaukee, WI 53212
(414) 263-1600

Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013
(202) 205-0549

Soiltest, Incorporated
86 Albrecht Drive
P.O. Box 8004
Lake Bluff, IL 60044
(708) 295-9400
(800) 323-1242

Stevens Water Resources Products
Leupold & Stevens, Incorporated
P.O. Box 688
Beaverton, OR 97075
(503) 646-9171

Stork Acoustical Systems, Incorporated
510 Castillo Street
Santa Barbara, CA 93101
(805) 962-9282

Teledyne Gurley
514 Fulton Street
P.O. Box 88
Troy, NY 12181
(518) 272-6300
(800) 759-1844

T.N. Technologies
P.O. Box 800
2555 North IH35
Round Rock, TX 78680
(512) 388-9100, 9200
(800) 736-0801

Turner Designs
845 West Maude Avenue
Sunnyvale, CA 94086
(408) 749-0994

U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, CA 95616
(916) 756-1104

U.S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460
(703) 883-8328
(800) 424-9067

U.S. Geological Survey
Water Resources Division
Gulf Coast Hydrosciences Center
Hydrologic Instrumentation Facility
Building 2101
Stennis Space Center, MS 39529
(601) 688-1577

U.S. Geological Survey
Water Resources Division
437 National Center
12201 Sunrise Valley Drive
Reston, VA 22092
(703) 648-5695

VWR Scientific, Incorporated
3700 Havana Street
Denver, CO 80239
(303) 371-0970
(800) 933-4959

Yellow Springs Instrument Company, Inc.
P.O. Box 279
Yellow Springs, OH 45387
(513) 767-7241

As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental an cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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